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THE HAWAIIAN MONK SEAL ON LISIANSKI ISLAND, 1988 AND 1990

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ABSTRACT

The endangered Hawaiian monk seal, *Monachus schauinslandi*, was studied on Lisianski Island in the Northwestern Hawaiian Islands during 16-18 May and 29 August 1988 and 10 June-11 August 1990. The 1990 field effort was the most intensive at this location since 1983. Data collected in 1988 were on reproduction and factors affecting survival and in 1990 also included haul-out patterns and population structure. In 1988, a minimum of 23 births were documented; 18 pups (10 males and 8 females) were tagged. A minimum of 17 pups (9 males and 8 females) were born in 1990; all were weaned and tagged. Only one entire nursing period (38 days) was observed in 1990. No pup fostering was documented. Of the 10 lactating females observed (4 in 1988, 4 in 1990, and 2 in both years), 7 were identified from previous years. Eighteen juvenile and subadult seals were tagged in 1990. No censuses were conducted in 1988. In 1990, census counts including pups ranged from 55 to 95 seals ($\bar{x}$ = 81); counts excluding pups ranged from 46 to 82 seals ($\bar{x}$ = 71). A total of 192 seals, excluding pups, were individually identified in the 1990 population. Six seals moved interatoll in 1988, and nine seals in 1990. Three adult seals sustained an injury in 1988; two were inflicted by adult males. At least 23 injuries were sustained across all age groups in 1990. Fourteen were mating injuries inflicted by adult males; most of the seals injured were adult females. Four seals (two in 1988 and two in 1990) were found entangled in debris: two were released by observers, one escaped without intervention, and one died. Eight deaths were documented in 1988--one was due to net entanglement and the remainder were of unknown causes. No deaths were observed in 1990, but one adult seal of unknown sex disappeared; circumstantial evidence indicates that it probably died at sea. Net and fishing debris totaling 717 items, accumulated between 1988 and 1990, were inventoried and destroyed in 1990.

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INTRODUCTION

Lisianski Island (lat. 26°02'N, long. 174°00'W) in the Northwestern Hawaiian Islands is one of the major haul-out and pupping areas used by the endangered Hawaiian monk seal, *Monachus schauinslandi*. The National Marine Fisheries Service (NMFS) has established research camps on Lisianski Island in each year since 1981 as part of an ongoing research program aimed at monitoring and aiding in the recovery of Hawaiian monk seals. Findings of past research are presented in DeLong et al. (1984) for 1981, Stone (1984) and Johanos and Henderson (1986) for 1982, Johanos and Kam (1986) for 1983, Alcorn et al. (1988) for 1984 and 1985, Westlake and Siepmann (1988) for 1986, and Johanos and Withrow (1988) for 1987.

The short duration of the 1988 field effort restricted the research objectives to individual identification by natural markings and tags and tagging weaned pups; though limited information on reproduction, interatoll movement, survival, injuries, entanglements, and deaths was also collected. A portion of the debris capable of entangling seals was inventoried. The primary objectives of the 1990 field season were to assess the status of the population by conducting frequent censuses, bleach marking all adult and subadult seals in the population, re-marking molting adults and subadults, and continuing individual identification by natural markings; monitoring reproduction; tagging all weaned pups and all untagged immature seals; monitoring interatoll movement, survival, injuries, entanglements, disappearances, and deaths; collecting tissue samples from weaned pups and juvenile and subadult seals for DNA analysis; and inventorying and destroying debris capable of entangling seals. The data collected during the 1988 and 1990 field seasons are summarized in this report.

MATERIALS AND METHODS

Field camps were established 16-18 May and 29 August 1988 and 10 June-11 August 1990 on Lisianski Island, which is within the Hawaiian Islands National Wildlife Refuge. (See Appendix A for an itinerary of the 1988 and 1990 fieldwork at Lisianski Island.)

In 1982, the island perimeter was divided into 49 sectors of nearly equal size for designation of seal locations (Fig. 1). These sectors are marked by either plastic poles or natural features and have been used in subsequent field seasons for seal location data. The island's geology, flora, fauna, and history are detailed in Clapp and Wirtz (1975).

Individual Identification

Individual seals were identified by tags, applied bleach marks, or natural markings. They were also classified by sex and size. All individual seals mentioned in this report are referred to by unique permanent or temporary identification numbers. Procedures for seal identification and size classification are detailed in Stone (1984).

Weaned pups present at the beginning of the field camps were tagged as soon as possible on each hind flipper with a uniquely numbered, green, plastic Temple Tag which included coding of year and island of birth (Gilmartin et al. 1986). Pups that weaned during the field camps were tagged within a few days post-weaning.

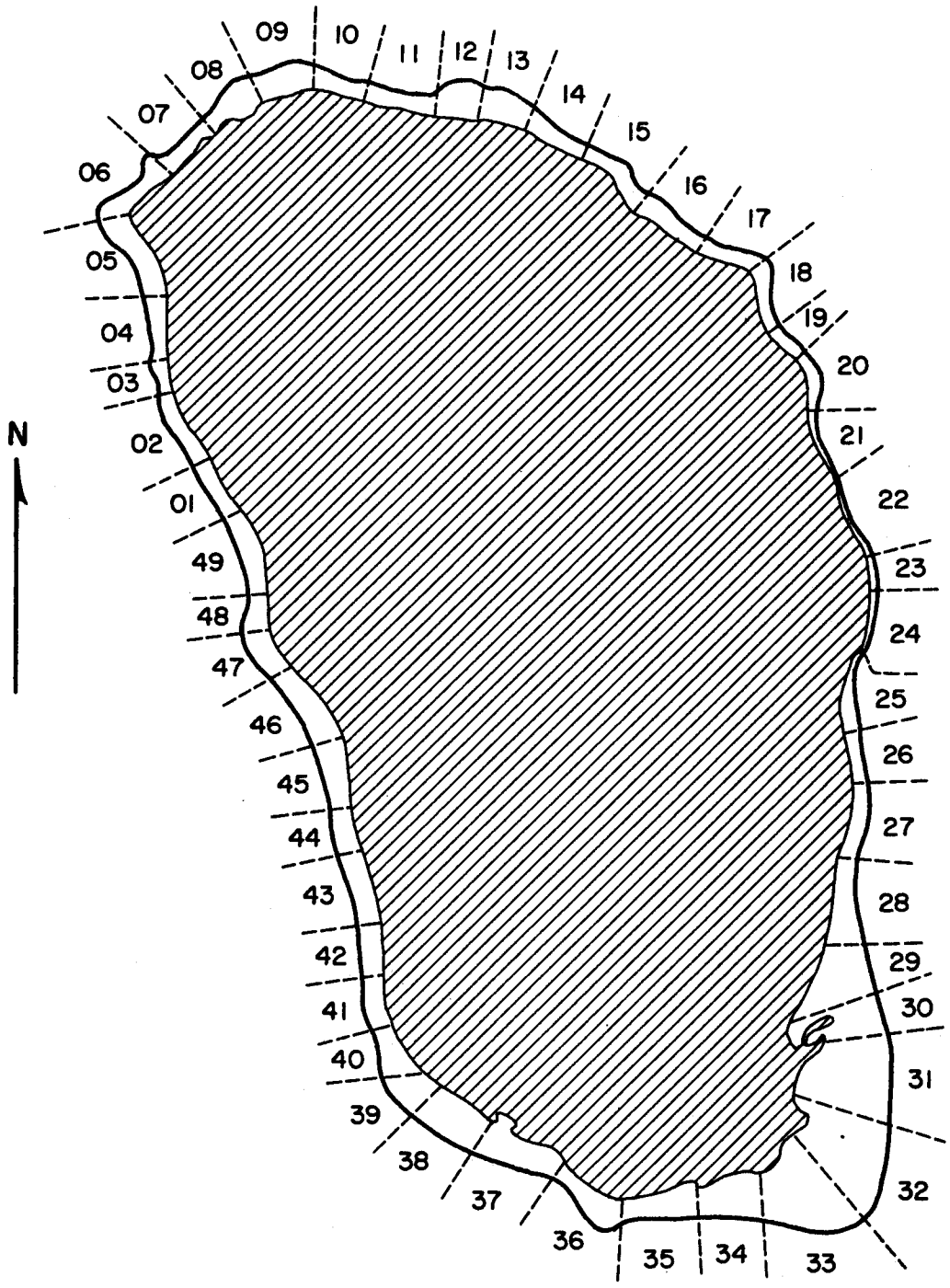

Figure 1.--Map of Lisianski Island showing 49 sectors.

Attempts were also made in 1990 to tag all yearling and 2-year-old seals that were not tagged as pups in 1988 and 1989. These animals were tagged on each hind flipper with a uniquely numbered, green, plastic Temple Tag with a numbering series indicating that age and birth location were not known. In addition, older animals sighted with lost or broken tags were retagged on an opportunistic basis. Adult and subadult seals without tags or with worn tags were bleach marked for individual identification, and bleach-marked animals that molted were rebleached to maintain their identities. Bleach-marking techniques and the composition of the solution used are described in Johanos et al. (1987).

Tags, bleach marks, scars, and other natural markings were sketched on a scar card for each seal. Scar cards were revised throughout the field season to ensure a current file. Photographs of scars and natural markings were taken opportunistically to create an individual identification file or to supplement files begun in earlier years.

Censuses and Patrols

Only incidental patrols were conducted on Lisianski Island once or twice each day during the 1988 field season. Types of data collected in 1990 and a typical daily schedule are summarized in Appendix B. From 12 June to 8 August, the combination of censuses and patrols ensured that the beaches were surveyed at least once a day, except for 1 day when coverage was not possible because of logistical difficulties.

Observers used vegetation for cover and stayed above the beach crest whenever possible to minimize disturbance to the seals. Census and patrol data were recorded on the standard census form (Forsyth et al. 1988) according to the 1990 coding instructions in Appendix C.

Censuses

Census methods and criteria used for counting seals are outlined in Johanos et al. (1987). Two observers conducted a census every second day from 14 to 30 June, and every third day from 3 July to 8 August, starting at 1300 Hawaii standard time (Appendix B) and lasting approximately 1.5 hours each. Census duties were rotated among three field personnel. Observers started simultaneously in sector 49 and traveled in opposite directions until they met, usually in sectors 22-27. Each person changed the direction of travel on alternate censuses.

Morning Patrols

The morning patrols primarily were for bleach marking and scar data collection; however, all seals, their behavior, and other noteworthy events were recorded with the same methodology used in the censuses. Morning patrols covering the entire island were performed by one observer each day from 13 June to 5 July 1990 and, thereafter, only on non-census days. These patrols typically began at about 0700 and lasted approximately 3.0 hours.

Afternoon Patrols

The primary focus of the afternoon patrols, until 30 June, was tagging and bleach marking. From 1 July to 7 August, after the majority of the weaned pups and immature seals had been tagged, the afternoon patrols were devoted to bleach marking and scar data collection. In addition, all seals, their behavior, and noteworthy events were recorded with the same methodology used in the censuses. Afternoon patrols of the entire island were conducted daily in 1990 by two to three observers. Starting time was typically 1630, and duration was approximately 2.0 hours.

Incidental Patrols

During incidental patrols in 1988 and 12 June-8 August 1990, data recorded on census forms included sightings of identified individuals, molting seals, nursing mother-pup pairs, and other noteworthy events. The island was monitored for seals marked at other islands and for events such as births, deaths, weanings, adult male aggression, shark-seal interactions, entanglements, injuries, and illnesses. Weaned pups were tagged during incidental patrols in 1988.

Collection of Samples

Skin samples (tissue plugs collected during tagging efforts) were collected in 1990 from weaned pups and immature seals for DNA analysis. These DNA samples will be used to help identify the breeding animals and to better understand the male breeding hierarchy at Lisianski Island. Procedures and results of the DNA analysis will be reported elsewhere.

RESULTS AND DISCUSSION

Census Counts

A total of 22 censuses and 91 patrols were conducted on Lisianski Island in 1990. Census counts including pups ranged from 55 to 95 seals (mean, 81); counts excluding pups ranged from 46 to 82 seals (mean, 71; Table 1).

Population Structure

In 1988, a total of 86 individual seals (including 3 nursing pups) were identified, but they composed an unknown portion of the entire population. In 1990, 209 individuals (192 excluding pups) were identified by tags, bleach marks, or distinctive natural markings (Table 2). This total does not represent the entire population, though most individuals were identified. The sex ratio of identified males to females was 1.4:1 for the immature size classes (juveniles and subadults) and 2.3:1 for the adults.

Since 1982, the mean beach count excluding pups decreased from 97.5 animals in 1982 to 86 in 1983, and to 71 in 1990. The number of adult males and females and their observed sex ratio in 1990 remained similar to the numbers seen in 1982 and 1983. In 1982, 1983, and 1990, adult males totaled 101, 101, and 95, respectively, and adult females totaled 41, 40, and 41, respectively.

Table 1.--Hawaiian monk seal census counts for Lisianski Island, 1990 (M = male, F = female, and U = unknown).

	Adult			Subadult			Juvenile			Pup			Total		
Date	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
6/14	20	9	22	4	5	11	2	1	1	2	1	10	75	13	88
6/16	7	11	17	7	1	14	1	2	6	2	3	9	66	14	80
6/18	13	13	13	5	1	18	1	0	2	2	2	7	66	11	77
6/20	14	15	17	4	1	11	2	1	4	3	1	8	69	12	81
6/22	12	13	23	3	5	13	3	1	6	1	1	8	79	10	89
6/24	18	11	22	6	4	11	1	0	2	2	3	7	75	12	87
6/26	19	14	20	6	3	12	0	0	5	2	3	7	79	12	91
6/28	20	17	12	6	6	15	1	0	2	3	2	8	79	13	92
6/30	5	7	21	1	2	5	0	0	5	2	1	6	46	9	55
7/03	15	12	28	5	4	7	1	0	2	2	1	8	75[a]	11	86
7/06	13	10	20	6	4	12	0	1	4	2	1	7	70	10	80
7/09	17	14	18	7	3	17	2	0	4	0	0	8	82	8	90
7/12	27	10	21	7	3	8	4	0	1	2	5	7	81	14	95
7/15	14	9	18	7	3	11	2	2	0	3	4	4	66	11	77
7/18	25	10	18	6	3	14	1	1	1	2	3	5	79	10	89
7/21	14	12	12	2	4	10	3	0	4	1	0	7	61	8	69
7/24	21	10	17	4	4	9	1	0	5	2	1	7	71	10	81
7/27	28	10	17	7	3	7	0	0	6	1	1	7	78	9	87
7/30	17	8	10	10	0	8	0	1	1	3	1	3	55	7	62
8/02	21	8	15	7	3	12	0	0	2	0	0	7	68	7	75
8/05	27	7	18	3	1	7	1	1	4	2	1	4	69	7	76
8/08	26	7	19	5	1	9	0	0	1	3	3	4	68	10	78
Mean	17.9	10.8	18.1	5.4	2.9	11.0	1.2	0.5	3.1	1.9	1.7	6.7	70.8	10.4	81.1
Var.	38.0	7.2	16.3	4.0	2.4	10.8	1.2	0.4	3.5	0.7	1.7	2.9	75.3	4.5	93.5

[a]Total includes some seals which were not placed in any size class.

Table 2.--The numbers of individuals observed, by sex and estimated midsummer size class, at Lisianski Island during the 1982, 1983, and 1990 field seasons. Sex ratio is the number of males to females.

Size	Male			Female			Unknown			Total			Sex ratio		
	1982	1983	1990	1982	1983	1990	1982	1983	1990	1982	1983	1990	1982	1983	1990
Adult	101	101	95	41	40	41	0	0	3	142	142	139	2.5:1	2.5:1	2.3:1
Subadult	24	30	21	21	23	16	0	0	0	45	53	37	1.2:1	1.3:1	1.3:1
Juvenile	18	24	10	10	16	6	0	0	0	28	40	16	1.8:1	1.5:1	1.7:1
Pup	16	7	8	11	18	9	0	0	0	27	25	17	1.9:1	0.4:1	0.9:1
Total	159	162	134	83	97	72	0	0	3	242	258	209	1.9:1	1.7:1	1.9:1
Total (excluding pups)	143	155	126	72	79	63	0	0	3	215	233	192	2.0:1	2.0:1	2.0:1

The number of pups dropped from 27 in 1982 and 25 in 1983 to 17 in 1990. The largest decrease, however, occurred in the immature size classes for both sexes. Immature males declined from 42 in 1982 and 54 in 1983 to 31 in 1990, and immature females declined from 31 in from 1982 and 39 in 1983 to 22 in 1990. The sex ratio for the immature classes remained at 1.4:1 in 1982, 1983, and 1990.

Tagged Seals

Tagged pups totaled 18 in 1988 and 17 in 1990. A summary of the number of pups born, tagged, and resighted from 1982 to 1990 is in Table 3.

The very brief field season in 1988 and no field effort in 1989 precluded many pups from being tagged in those years. Tagging efforts in 1990 focused on these yearlings and 2-year-olds (n = 18), using Temple Tags with a numbering scheme denoting that the age and birth location of these animals were not known (Table 4). Three animals lost one of their Temple Tags during the 1990 field season. Juvenile male G1AK was first observed with its right tag missing on 7 July and was retagged on 23 July; juvenile male GF18 was first noted as missing its right tag on 17 June and was retagged on 5 July (Table 5). Also, subadult G2AK was sighted with its left tag missing on 7 August but was not sighted again before the termination of the camp on 11 August and therefore could not be retagged (Table 4).

Reproduction

Pup Production

For 1988, a minimum of 23 births (10 males, 8 females, and 5 unknown sex) were documented. During the May visit, sixteen weaned pups were tagged, and six nursing pups and one mummified pup carcass (death No. 07LI88) were observed. By 29 August, no nursing pups were present, and only three untagged, weaned pups were observed; two of these pups were tagged and the third was found dead, entangled in a net (death No. 08LI88). It is likely that the number of births was higher than 23, but that weaned pups escaped detection because of the timing and brevity of the research efforts.

A minimum of 17 pups (9 males and 8 females) were born in 1990 (Table 3): 11 were weaned when the field party arrived, 5 pups were nursing at the start of the camp, and one more pup was born during the field season on 17 June. The latter pup nursed 38 days which is within the normal range. All pups were tagged and all were sighted within the last 7 days of the field camp. No evidence of pup mortalities that may have occurred prior to the start of the field camp was observed. There were no obviously preparturient females upon termination of the camp. The six mother-pup pairs observed were along the southeastern portions of the island (sectors 19-27, Fig. 1), similar to the major pupping areas observed in previous years.

The birth rate (percentage of adult females that gave birth) dropped from 66% in 1982 and 63% in 1983 to 41% in 1990. The number of adult females remained at 40-41 in these 3 years (Table 2).

Table 3.--Number of Hawaiian monk seal pups born, tagged, and resighted at Lisianski Island, 1982-90.[a]

Year	Known births[b] (No.)	Pups tagged[c] (No.)	No. of tags resighted by year[c] 1983	1984	1985	1986	1987	1988	1989[d]	1990
1982	28(16,11,1)	13(7,6)	11(5,6)	11(5,6)[e]	11(5,6)[f]	11(5,6)	9(5,4)	7(5,2)[g]	6(4,2)	6(4,2)
1983	25(7,18,0)	24(6,18)	--	21(6,15)[h]	20(6,14)[i]	19(5,14)	19(5,14)[j]	17(5,12)[k]	13(4,9)	13(4,9)[l]
1984	16(10,5,1)	15(10,5)	--	--	14(9,5)	12(9,3)	12(9,3)[m]	10(7,3)[n]	9(6,3)	9(6,3)[o]
1985	15(6,9,0)	14(5,9)	--	--	--	14(5,9)[p]	12(4,8)[q]	6(3,3)[r]	5(2,3)	5(2,3)[s]
1986	22(11,9,2)	20(11,9)	--	--	--	--	18(10,8)	15(10,5)[t]	14(10,4)	14(10,4)[u]
1987	19(12,6,1)	18(12,6)	--	--	--	--	--	11(5,6)[v]	9(4,5)	9(4,5)[w]
1988	23(10,8,5)	18(10,8)	--	--	--	--	--	--	15(8,7)	15(8,7)
1989[x]	--	--	--	--	--	--	--	--	--	--
1990	17(9,8,0)	17(9,8)	--	--	--	--	--	--	--	--

[a]Birth and tag data for 1982-87 are from the following sources: 1982, Johanos and Henderson (1986); 1983, Johanos and Kam (1986); 1984, 1985, Alcorn et al. (1988); 1986, Westlake and Siepmann (1988); 1987, Johanos and Withrow(1988).

[b]Numbers in parentheses equal the numbers of males, females, and seals of unknown sex, respectively.

[c]Numbers in parentheses equal the numbers of males and females, respectively.

[d]These numbers represent minimum survival, as resightings could not be made because there was no field effort at Lisianski Island in 1989.

[e]This figure includes a seal not seen in 1984 but resighted in 1985 at Lisianski Island and another seal resighted at Laysan Island in 1984.

[f]This figure includes a seal resighted at Laysan Island in 1985.

[g]This figure includes four seals not seen in 1988 but resighted at Lisianski Island in 1990.

[h]This figure includes a seal not seen in 1984 but resighted at Lisianski Island in 1985 and another seal resighted at Laysan Island in 1984.

Table 3.--Continued.

[i]This figure includes two seals resighted at Laysan Island in 1985.

[j]This figure includes a seal resighted at Laysan Island in 1987.

[k]This figure includes a seal resighted at Laysan and Lisianski Islands in 1988 and nine seals not seen in 1988 but resighted at Lisianski Island in 1990.

[l]This figure includes a seal resighted at Laysan Island in 1990.

[m]This figure includes a seal not seen in 1987 but resighted at Lisianski Island in 1990 and three seals that were resighted at Laysan Island in 1987 (one of which was seen at both Laysan Island and Pearl and Hermes Reef).

[n]This figure includes two seals resighted at Laysan Island in 1988, a seal resighted at Pearl and Hermes in 1988, and three seals not seen in 1988 but resighted at Lisianski Island in 1990.

[o]This figure includes a seal resighted at Laysan Island in 1990.

[p]This figure includes a seal resighted at Laysan Island in 1986.

[q]This figure includes three seals resighted at Laysan Island in 1987.

[r]This figure includes a seal resighted at Laysan Island in 1988.

[s]This figure includes a seal resighted at Laysan Island in 1990.

[t]This figure includes a seal resighted at Laysan Island in 1988 and three seals not seen in 1988 but resighted at Lisianski Island in 1990.

[u]This figure includes two seals resighted at Laysan Island in 1990.

[v]This figure includes four seals not seen in 1988 but three resighted at Lisianski Island and one resighted at Laysan Island in 1990.

[w]This figure includes a seal resighted at Laysan Island in 1990.

[x]This information is not available for 1989 as there was no field effort at Lisianski Island during that year.

Table 4.--Juvenile and subadult Hawaiian monk seals tagged on Lisianski Island, 1990 (J = juvenile, S = subadult, M = male, and F = female).

ID No.	Tag No[a] L	Tag No[a] R	Size	Sex	Tagging date
G1AA	1AA	1AB	J	M	6/13
G1AC	1AC	1AD	J	M	6/13
G1AE	1AE	1AF	J	F	6/15
G1AH	1AG	1AH	J	F	6/16
G1AI	1AI	1AJ	J	M	6/19
G1AK	1AK	1AL[b]	J	M	6/20
G1AM	1AM	1AN	J	M	6/23
G1AO	1AO	1AP	J	F	7/01
G1AQ	1AQ	1AR	J	F	7/01
G1AS	1AS	1AT	J	M	7/05
G2AA	2AA	2AB	J	M	6/13
G2AD	2AC	2AD	S	M	6/13
G2AE	2AE	2AF	S	M	6/19
G2AG	2AG	2AH	S	M	6/20
G2AI	2AI	2AJ	S	M	6/21
G2AK	2AK[c]	2AL	S	F	6/23
G2AN	2AN	2AM	S	F	6/28
G2AP	2AP	2AO	S	M	7/05

[a]Green Temple Tags, L = left hind flipper, and R = right hind flipper.
[b]G1AK lost its right tag (1AL) and was retagged (1AU) later in the season.
[c]G2AK lost its left tag (2AK) but could not be retagged.

Table 5.--Hawaiian monk seals retagged with green Temple Tags on Lisianski Island, 1990.

		Left tag		Right tag		
ID No.	Sex[a]	New	Old[b]	New	Old[b]	Date
GF18	M	--	F18	F20	F19	5 July
G1AK	M	--	1AK	1AU	1AL	23 July

[a]M = male
[b]Old tags were lost; new tags were inserted into new tag holes.

Pup Exchanges

No pup fostering was observed among the mother-pup pairs at Lisianski Island in 1988 and 1990.

Parturient Females

Of the 10 parturient females observed in 1988 and 1990 (4 in 1988, 4 in 1990, and 2 in both years), 7 were identified from previous years (Table 6). No previous pupping record existed for adult female G173 before1988, and she was not sighted in 1990. Adult female G171 was first observed to pup in 1990, though she was sighted in 1987. Adult female G035, born and tagged on Lisianski Island in 1982, was first documented to pup in 1990. Adult female GA01 pupped in 1982, 1983, 1986, 1987, 1988, and 1990. Adult female GA29, parturient in 1990, was known to have pupped in 1982, 1983, and 1987. Adult female GA36, also parturient in 1990, was last observed to pup in 1982, though she was sighted in 1983. Prior to pupping in both 1988 and 1990, adult female GA34 was last observed with a pup in 1982 and 1983. Coverage of breeding seasons after 1983 was incomplete, so these females may have pupped in other years.

At the start of the 1990 field camp, a nursing mother (G171) was observed with a severe mobbing wound which was probably inflicted during pregnancy. However, she successfully weaned her pup, GG20, which had a normal axillary girth of 120 cm after weaning.

Interatoll Movement

Interatoll movement was documented for six seals in 1988 and nine seals in 1990 (Table 7). Subadult female TN53 and adult male GT30 from Laysan Island and adult male K501 from Kure Atoll immigrated to Lisianski Island by 1990. Juvenile male Y322 journeyed northwest from French Frigate Shoals in 1987 to Laysan Island and then to Lisianski Island in 1988. Adult male GT24 was seen on Laysan Island in 1987 and Pearl and Hermes Reef in 1987 and 1988 and had immigrated to Lisianski Island by 1990. In addition, adult female BT10 emigrated from Lisianski Island to Laysan Island in 1988 and stayed through 1989, but was seen on Lisianski Island again

Table 6.--Summary of data on Hawaiian monk seal pups born on Lisianski Island, 1988 and 1990.

ID No.	Tag No.[a] L	Tag No.[a] R	Sex[b]	Birth Date	Birth Sector	Weaning Date	Weaning Sector	Nursing period (days)	Tagging date	Measurement[c] (cm) AG	Measurement[c] (cm) SL	Mother ID
						1988						
GF00	F00	F01	F	--	--	--	--	--	5/16	120	125	--
GF02	F02	F03	F	--	--	--	--	--	5/16	84	112	--
GF04	F04	F05	M	--	--	--	--	--	5/16	115	133	--
GF06	F06	F07	M	--	--	--	--	--	5/16	96	132	--
GF08	F08	F09	M	--	--	--	--	--	5/16	98	123	--
GF10	F10	F11	M	--	--	--	--	--	5/16	105	128	--
GF12	F12	F13	F	--	--	--	--	--	5/16	~110	117	--
GF14	F14	F15	F	--	--	--	--	--	5/17	91	125	--
GF16[d]	F16	F17	M	--	--	--	--	--	8/29	110	147	--
GF18[d]	F18	F19	M	--	--	--	--	--	8/29	--	--	--
GF30	F30	F31	M	--	--	--	--	--	5/16	87	124	--
GF32	F32	F33	F	--	--	--	--	--	5/16	84	120	--
GF34	F34	F35	M	--	--	--	--	--	5/16	91	131	--
GF36	F36	F37	F	--	--	--	--	--	5/16	85	127	--
GF38	F38	F39	F	--	--	--	--	--	5/16	96	133	--
GF40	F40	F41	M	--	--	--	--	--	5/16	88	120	--
GF42	F42	F43	M	--	--	--	--	--	5/16	92	121	--
GF44	F44	F45	F	--	--	--	--	--	5/16	98	128	--
GFX1[e]	---	--	U	--	--	--	--	--	--	--	--	--
GFX2[d,f]	--	--	U	--	--	--	--	--	--	--	--	--

Table 6.--Continued.

ID No.	Tag No.[a] L	R	Sex[b]	Birth Date	Sector	Weaning Date	Sector	Nursing period (days)	Tagging date	Measurement[c] (cm) AG	SL	Mother ID
						1990						
GG00	G00	G01	F	--	--	--	--	--	6/12	100	12	--
GG02	G02	G03	F	--	--	--	--	--	6/12	83	116	--
GG04	G04	G05	M	--	--	--	--	--	6/12	87	109	--
GG06	G06	G07	M	--	--	--	--	--	6/12	106	121	--
GG08	G08	G09	F	--	--	--	--	--	6/12	101	125	--
GG10	G10	G11	M	--	--	--	--	--	6/13	98	125	--
GG12	G12	G13	F	--	--	--	--	--	6/13	93	126	--
GG14	G14	G15	M	--	--	--	--	--	6/14	93	125	--
GG16	G16	G17	F	--	--	--	--	--	6/15	82	113	--
GG18	G18	G19	F	--	--	--	--	--	6/16	--	--	--
GG20	G20	G21	M	< 6/12	27	< 6/19	27	--	6/19	120	126	GA36
GG22	G22	G23	M	--	--	--	--	--	6/22	89	126	--
GG24	G24	G25	M	< 6/12	21	6/22-23	21	--	6/25	89	119	G035
GG26	G26	G27	F	< 6/12	19	7/01	21	--	7/01	105	121	G171
GG28	G28	G29	F	< 6/12	19	7/06	19	--	7/11	99	128	GA01
GG30	G30	G31	M	< 6/12	24	7/11-12	28	--	7/13	114	130	GA34
GG32	G32	G33	F	6/17	25	7/24	25	38	7/25	118	135	GA29

[a]Green Temple Tags, L = left hind flipper, and R = right hind flipper.

[b]M = male; F = female; U = unknown.

[c]AG = axillary girth; SL = straight length.

[d]Six adult nursing females (GA01, GA34, G173, Temp. M02, Temp. I, , and Temp. V) were identified in May; it is not known if any of these three pups belong to these females.

eDied prior to 16 May when mummified carcass was found.

[f]Died between 18 May and 29 August when decomposing carcass was found entangled in a net.

Table 7.--Interatoll movement of Hawaiian monk seals to and from Lisianski Island, 1988 and 1990 (A = adult, S = subadult, J = juvenile, M = male, and F = female).

	Tag No.[a]						Movement from		Movement to	
ID No.	L	R	Bleach No.	Tag color[b]	Size	Sex	Location	Date last seen	Location	Date first seen
BT10	T11	T10	--	B	S	F	Lisianski	08/20/87	Laysan	03/12/88
					A	F	Laysan	04/01/89	Lisianski	06/16/90
G054	A15	A16	500	G	S	F	Lisianski	8/24/87	Laysan	03/18/88
			--				Laysan	04/21/88	Lisianski	05/16/88[c]
G064	A27	A28	102	G	A	M	Lisianski	08/29/88	Laysan	04/12/90
GL16	L16	L17	--	G	S	M	Lisianski	05/18/88	Laysan	10/27/88
GL38	L38	L39	--	G	A	M	Lisianski	08/24/87	Laysan	06/29/90
GN56	N56	N57	196	G	S	F	Lisianski	08/21/87	Laysan	04/27/90
GT24	T24	T23	Calvin	G	A	M	P & H[d]	07/02/88	Lisianski	06/21/90
GT30	T30	T29	--	G	A	M	Laysan	05/28/89	Lisianski	06/16/90
K501	A04	A03	--	K	A	M	Kure	07/31/88	Lisianski	07/02/90
T08F	--	--	177[e]	--	A	F	Laysan	05/09/88	Lisianski	05/17/88
			177[e]				Lisianski	05/18/88	Laysan	06/01/88
			Vera/Dot				Laysan	06/02/88	Lisianski	06/19/90

Table 7.--Continued

ID No.	Tag No.[a] L	Tag No.[a] R	Bleach No.	Tag color[b]	Size	Sex	Movement from: Location	Movement from: Date last seen	Movement to: Location	Movement to: Date first seen
TN53	N53	N52	--	T	S	F	Laysan	07/06/89	Lisianski	06/13/90
TT34	T34	T33	--	T	S	M	Laysan	06/13/88	Lisianski	08/29/88
			--				Lisianski	08/29/88	Laysan	10/28/88
Y322	T33	T33	--	Y	J	M	FFS[f]	07/06/87	Laysan	03/09/88
			--				Laysan	04/13/88	Lisianski	08/29/88

[a]Temple tags, L = left hind flipper, and R = right hind flipper.

[b]Tag colors: B = blue, G = green, T = tan, and K = gray.

[c]Molted on Lisianski in 1988.

[d]P & H = Pearl and Hermes Reef.

[e]Bleached on Laysan in 1988.

[f]FFS = French Frigate Shoals.

in 1990. In 1988, subadault GL16 emigrated from Lisianski Island to Laysan Island, and by 1990 adult males GO64 and GL38 and subadult female GN56 did likewise. During 1988, subadult female G054 traveled round-trip from Lisianski Island to Laysan Island, and subadult male TT34 also made a round-trip originating from Laysan Island with a stopover at Lisianski Island. Adult female TO8F traveled round-trip from Laysan Island to Lisianski Island during 1988 and then emigrated to Lisianski Island in 1990.

Factors Affecting Survival

Injuries

Three injuries were documented in 1988, of which two were caused by adult mating attempts (Table 8).

At least 23 injuries were observed during the 1990 field season. Most injuries were due to adult male mating attempts, seal bites, and shark attacks (Table 8). Adult male mating attempts probably caused 14 injuries (61% of the total); of these, 11 were inflicted upon adult females. These attacks by adult males were not observed, but the injury location and pattern were typical of injuries caused by such attacks. Of the five injuries (22% of total) apparently inflicted by sharks, four were circular wounds typically inflicted by the cookiecutter shark, *Isistius brasiliensis*, and one was a more severe, clean laceration and gaping wound probably inflicted by the tiger shark, *Galeocerdo cuvier*. In addition, one injury was from a seal bite, and three (13% of the total) were from unknown sources. No known mortalities resulted from any of the injuries observed in 1990.

Net Accumulation and Entanglement

A total of 717 pieces of net, fishing line, and other debris capable of entangling wildlife were inventoried and destroyed in 1990. This total reflects 3 years of debris accumulation (1988-90) and includes an unknown portion of the 150 pieces that were inventoried in August 1988, but not destroyed. Debris accumulation was probably higher, because storm activity may have buried or removed debris deposited on the beach. In addition, four seals were seen entangled in debris (Table 9): In 1988, one seal was released by observers, and the other died from entanglement; in 1990, one was released by observers, and the other escaped by itself.

Case 1.--On 18 May 1988 at 1145, weaned female GF44 was observed asleep at the waterline of sector 24 with a plastic container stuck on the end of her snout. This container must not have been wedged on the seal's snout more than 2 days, as she was tagged on 16 May. The container was removed with minimal effort and disturbance to the seal.

Case 2.--On 29 August 1988, the carcass of weaned pup TZX2 was observed at the waterline of sector 25 with its head protruding from a 9-m-long net (stretched mesh, ~10 cm) that completely encircled its body. The trailing end of the net was twisted tightly. The head had been severed from the decomposing carcass, but this is thought to have occurred postmortem.

Table 8.--Injuries of Hawaiian monk seals at Lisianski Island, 1988 and 1990 (A = adult, S = subadult, J = juvenile, M = male, F = female, and U = unknown).

Injury No.	Date	Size	Sex	ID No.	Description of injury				
					Type	Location	Dimension (cm) Depth (cm)	Dimension (cm) (L x W or diam.)	Cause
					1988				
01	5/17	A	U	Temp. E	Gaping with numerous abrasions	Dorsal	2.5[b]	15 x 20	Adult male
02	5/17	A	U	Temp. Y	Abrasion	Hind flipper	--	--	Unknown
03	5/17	A	M	G058	Gaping	Dorsal	--	--	Adult male
					1990				
01	06/12	A	F	G171/Temp. 05	Gaping wound	Dorsal	2.5[b]	50 x 38	Adult male
02	06/14	A	F	GA18/Bleach EVI	Gaping wound	Dorsal	2.0[a]	46 x 15	Adult male
04	06/16	A	F	GA01/Temp. 04	Circular	Right lateral	2.0[a]	10 d	Shark
06	06/17	S	M	GL32	Gaping wound	Dorsal	2.5[b]	41 x 20	Adult male
07	06/19	S	F	GN04	Gaping wound	Dorsal	3.0[b]	46 x 18	Adult male
08	06/19	A	F	G056	Gaping wound	Dorsal	2.0[a]	20 x 15	Adult male
11	06/20	A	F	G047	Gaping wound	Dorsal	2.0[a]	25 x 13	Adult male
12	06/20	A	U	GS04	Gaping wound	Dorsal	2.0[a]	15 x 5	Adult male
13	06/23	A	F	Bleach ANN	Gaping wound	Dorsal	2.0[a]	15 x 10	Adult male
15	06/29	S	F	--	Abrasions and laceration	Left lateral	0.5[c,d]	Abrasions covered an area 30 x 46; laceration 4 d	Adult male
16	06/29	A	F	G079	Gaping wound	Dorsal	1.0[a]	15 x 8	Adult male
17	06/28	A	F	Bleach V/X	Gaping Wounds (2)	Dorsal	2.5[b]	10 x 10; 20 x 10	Adult male

Table 8.--Continued.

Injury No.	Date	Size	Sex	ID No.	Description of injury: Type	Location	Dimension (cm): Depth (cm)	Dimension (cm): (L x W or diam.)	Cause
18	06/30	A	F	BT10	Gaping wound	Dorsal	0.3[a]	8 x 8	Adult male
20	07/02	A	U	Bleach Z9	Gaping wound	Dorsal	1.0[a]	5 d	Adult male
22	07/02	A	F	Bleach V/X	Laceration	Dorsal head	1.0[c]	5 d	Seal bites
23	07/03	A	F	G054	Abcess	Dorsal	0.5[c]	2 d	Unknown
24	07/09	S	M	GJ10/Bleach EUG	Gaping wound	Right rear	1.5[b]	13 x 10	Shark
26	07/16	A	F	GA77/Bleach RON	Gaping wound	Dorsal	0.5[a]	10 x 10	Adult male
27	07/18	J	M	G1AJ	Circular	Right anterior lateral	1.0[a]	5 d	Shark
28	07/18	A	F	GA01/Temp. 04	Circular	Left posterior lateral	2.0[c]	3 x 4	Shark
30	07/19	J	M	GF18	Circular	Left anterior lateral	0.5[c]	2 d	Shark
32	08/05	S	M	G1AC	Gaping wound	Right head	1.0[a]	5 x 3	Unknown
33	07/22	J	M	GF18	Abcesses (3)	Right lateral	--	20 d each	Unknown

[a]Blubber layer.
[b]Fat layer.
[c]Skin broken.
[d]Surface scratch.

Table 9.--Hawaiian monk seal entanglements in debris at Lisianski Island, 1988 and 1990 (A = adult, S = subadult, W = weaned pup, M = male, F = female, and U = unknown).

				Location of seal			
Date	Size	Sex	ID No.	Sector	Beach position	Type of debris	Part of body entangled
05/18/88	W	F	GF44	24	Waterline	Plastic container	Snout[a]
08/29/88	W	U	TZX2	25	Waterline	Net	Whole body
06/17/90	A	F	GO62	24	Midbeach	Line	Torso[a]
07/02/90	S	M	GL34	08	Midbeach	Plastic ring	Snout[a]

[a]Movement was not restricted by this entanglement.

Table 10.--Hawaiian monk seal deaths at Lisianski Island, 1988.

Death No.	Date[a]	ID No.	Size[b]	Sex[c]	Probable cause of death
01LI88	<5/16	Temp. K[d]	A	F	Adult male?
02LI88	<5/16	GK14	S/A	M	Unknown
03LI88	<5/16	Temp. J	A	U	Unknown
04LI88	<5/16	GT10	S	M	Unknown
05LI88	<5/16	Temp. L[e]	U	U	Adult male?/Shark?
06LI88	<5/16	Temp. M	U	U	Unknown
07LI88	<5/16	TZX1	P	U	Unknown
08LI88	<8/29	TZX2[f]	W	U	Net entanglement

[a]Date found dead.

[b]A = adult, S = subadult, P = nursing pup, W = weaned pup, and U = unknown.

[c]M = male, F = female, and U = unknown.

[d]Found at waterline with large openings on the dorsum; may have sustained mobbing injuries.

[e]Partial carcass seen offshore; dorsum was open, possibly from mobbing injury or shark attack.

[f]See Net Accumulation and Entanglement Case 2.

Case 3.--On 17 June 1990 at 1911, adult female GO62 was observed midbeach on the rocky area of sector 24 with its torso loosely encircled by a line fragment. The seal's movement did not appear to be restricted, but the potential for further entanglement existed. Observers approached the seal while it was asleep, and quickly removed the line. The seal awoke, went into the water, and swam away. Seal GO62 was later seen on 18 June.

Case 4.--On 2 July 1990 at 1822, subadult male GL34 was observed at midbeach in sector 8 with a plastic ring loosely encircling his snout. The animal vocalized at the observer, opening its mouth completely, and entered the water and swam away with the ring still on its snout. The plastic ring was broken and did not form a complete circle and therefore did not appear to be restricting movement of the seal's mouth. Subadult male GL34 was later observed on 3 July free of the plastic ring.

Disappearances and Probable Deaths

Observation time was too brief to document any disappearances of animals in 1988, but one seal was known to have disappeared during the 1990 field season. An adult of unknown sex (bleach No. E5) appearing sick and emaciated was seen sporadically throughout the beginning of the season. The last sighting of this seal was on 22 June; it presumably died at sea.

Deaths

Although observation time was brief in 1988, eight seal carcasses in various stages of decomposition were recovered (Table 10). One seal died as a result of entanglement in a derelict net, two may have sustained mobbing injuries, and the remaining five died from unknown causes. No internal examinations of the carcasses were performed since the body tissues were autolyzed and research time was limited.

No known deaths occurred during the 1990 field season.

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APPENDIXES

Appendix A.--Itinerary of the fieldwork conducted on Lisianski Island in 1988 and 1990 by the National Marine Fisheries Service.

Date	Event
	1988
05/16	NOAA ship *Townsend Cromwell* arrives at Lisianski Island; disembarks B. Becker, R. Brainard, M. Brown, B. Choy, R. Forsyth, L. Hiruki, R. Westlake, and cooperating U.S. Fish and Wildlife Service (USFWS) scientists D. Evans and J. Marks. Incidental patrols begin. *Townsend Cromwell* embarks Choy, Forsyth, Hiruki, and Westlake.
05/18	*Townsend Cromwell* arrives; disembarks Forsyth and Westlake. Incidental patrols end. Lisianski field camp is disbanded and the *Townsend Cromwell* embarks Becker, Brainard, Brown, Forsyth, Westlake, and cooperating USFWS scientists Evans and Marks.
08/29	*Townsend Cromwell* arrives; disembarks G. Boehlert, R. Brainard, R. Forsyth, R. Humphreys, and R. Wilcox. Incidental patrol begins and ends. *Townsend Cromwell* embarks Boehlert, Brainard, Forsyth, Humphreys, and Wilcox.
	1990
06/10	*Townsend Cromwell* arrives at Lisianski Island; disembarks M. Lee, L. Timme, R. VanToorenberg, and cooperating scientist A. Zeigler.
06/12	Incidental patrols and tagging begin.
06/13	Bleach marking begins.
06/14	Censuses begin.
07/08	*Townsend Cromwell* arrives with additional supplies and departs.
08/08	Censuses and patrols end.
08/11	*Townsend Cromwell* arrives and embarks Lee, Timme, VanToorenberg, and cooperating scientist Zeigler.

Appendix B.--Data type summary and typical daily schedule for Hawaiian monk seal research at Lisianski Island, 1990.

Data Type

1.	C:	Census data:	14 June-8 August
		Data:	standard census
		Area:	entire island
		Frequency:	every second day (14-30 June)
			every third day (3 July-8 August)
		Time:	1300-1500
		Observers:	2
2.	P:	Patrol	
	(a)	AM Patrol:	13 June-7 August
		Data:	bleach marking, scar collection, and standard census
		Area:	entire island
		Frequency:	daily (13 June to 5 July)
			every non-census day (7 July-7 August)
		Time:	0700-1000
		Observers:	1
	(b)	PM Patrol:	13 June-7 August
		Data:	tagging, bleach marking, scar collection, and standard census
		Area:	entire island
		Frequency:	daily
		Time:	1600-1800
		Observers:	2
3.	I:	Incidental (no criteria)	

Typical Schedule

1. Census day (every second day, 14 June-30 June; every third day, 3 July-8 August)

0700-1000	AM patrol
1300-1500	Census
1600-1800	PM patrol

2. Non-census day

0700-1000	AM patrol
1600-1800	PM patrol

Appendix C.--Directions for the 1990 standard census form.

ISLAND--Name of island and atoll; e.g., East, FFS

OBSERVER--Three initials

TIME BEGIN and END--On a 24-hour clock, e.g., 6 p.m. = 1800, for the group of pages

DATA TYPE--C = Census = a complete count on an island begun around 1300
A = Atoll-wide census (usually completed within 2 days)
P = Patrol = any other observation not on a timed census
I = Incidental observations
Other letters may be used at your discretion to indicate specific kinds of non-census data, e.g., M for male observations.

NUMBER--Censuses and patrols may be assigned numbers at your discretion. Atoll counts extending over more than 1 day must be numbered.

PAGE--If census (or patrol) requires three pages, then mark first page as "page 1 of 3" and so on. If more than one person conducts the census, then combine page numbers; person A has pages 1 and 2, while person B has pages 3 and 4 of a four-page census day.

TEMP.--Temperature in degrees Celsius at beginning of census or patrol

WIND--Speed: 0 = no wind, calm (< 5 knots)
1 = light breeze (5-15 knots)
2 = strong wind (> 15 knots)
Thus, 2 N N = strong wind from north

Direction: NW, NN, NE, EE, SW, SS, SE, WW

CLOUD--Cloud cover: 00 = no clouds
01-09 = 10 to 90% cover
10 = 100% cover

PREC.--Precipitation: 0 = no precipitation or trace
1 = mist/drizzle
2 = rain
3 = intermittent rain

SECTOR--Location on island (e.g., 1-49 on Lisianski; 99 = no island)

SIZE--P1 = Nursing pup, wrinkles
P2 = Nursing pup, no wrinkles
P3 = Nursing pup, blimp, black
P4 = Nursing pup, molting
P5 = Nursing pup, molted

P = Nursing pup

Appendix C.--Continued.

PW = Prematurely weaned or undersized pup

W = Weaned pup

J1 = Juvenile I
J2 = Juvenile II
→ J = Juvenile
S3 = Subadult III
S4 = Subadult IV
→ S = Subadult
→ I = Immature

A = Adult

T1 = Turtle, juvenile (< 65 cm)
T2 = Turtle, subadult (65 - 80 cm)
T3 = Turtle, adult (> 80 cm)
→ T = Turtle

U = Seal of unknown size

SEX--M = Male
F = Female
U = Unknown

ID--Record ID number of seal if known; right justified: seal #25 = _25

? column: √ or 1 = ID number is questionable

√ 0 = seal is definitely not an IDed animal

BLEACH--Bleach number of seal if known; right justified; these columns may also be used for any temporary numbers assigned in the field

? column: √ or 1 = bleach is present, but the number is questionable
0 = seal is definitely unmarked
4 = partially read bleach number completed from other data

TAG--Tag number if known; right justified: tag #K23 = _K23. Put the alpha prefix of the temple tag (combined with tag ? column code = 5) if you can determine the hole drilling pattern, but can't decipher the number.

L/R: Tag position L = tag on left flipper
R = tag on right flipper
B = tags on both flippers
(only one tag number need be entered)

Appendix C.--Continued.

COL: Color code
T = tan (Laysan)
K = gray (Kure)
Y = yellow (FFS)
M = metal
G = green (Lisianski)
R = red (Midway, Necker, Nihoa)
B = blue (Pearl and Hermes)
P = plastic Riese

? column: √ or 1 = seal is tagged, but the number is questionable
0 = seal is definitely not tagged
4 = partially read tag completed from other data
5 = incompletely read tag, but partial data are certain

BEACH POS.--Location of seal or turtle when observer comes abreast of animal (e.g., if seal is seen midbeach from a distance and yet is at the waterline when the observer comes abreast, the seal is recorded as being at the waterline).

0 = animal floating in water or on an offshore rock (not included in census tally but may be used for behavioral data)
1 = along waterline, on wet sand
2 = midbeach, on dry sand
3 = vegetation zone or beach crest, on permanent beach

MOLT--Percentage of old pelage lost, optional for nursing pups

blank or 0 = no molting evident
_1-_99 = 1 to 99% molted (right justified)
100 = 100% molted, freshly molted, up to 1 month after molt

? column: √ or 1 = % molt estimate is questionable
0 = seal is definitely not molting

DISTURB--The degree to which the seal may have been disturbed by observer

blank or 0 = no disturbance, or seal merely looked at observer
1 = seal vocalized, gestured, or moved ≤ 2 body lengths
2 = seal alerted to observer and moved > 2 body lengths
3 = seal alerted to observer and fled into water

TIME--The time of an observation, on a 24-hour clock

ASSOCIATION DATA--There is room to describe two different associations (A and B).

Active associations
1) noted for all except behaviors between mother and nursing pup
2) must take place within 30 m of observer
3) subjects may be any distance apart

Spatial associations
1) noted as observer comes abreast of the subject
2) entangling object: distances < 2 m away

Appendix C.--Continued.

3) individual seals and turtles
- mother-pup pair (**N**): any distance
- all others (**L**): distances < 10 m away, record two nearest neighbors in straight line of sight
- record seal-seal and turtle-seal but not turtle-turtle associations

LINE NO.--Identity of the other party in the association

1) if a seal or turtle, put its line number here
(note line number refers to within same census page only)
2) if an entangling object, put
NR or 99 = net and/or rope
FL or 98 = flotsam other than above

DIST.--Closest distance during behavior
0 = body contact
1 = <2 m
2 = 2-5 m
3 = >5 m (>5 m but ≤ 10 m in the case of **L** behavior code)

BEHAVIOR--Up to four behaviors may be recorded for each association, but **N, E, X,** and **O** should not appear together with other behaviors

1) individual seal or turtle

a) active behavior

A = approach/investigate/sniff/nudge		
B1 = bite, nip	⟩	B = bite
B2 = bite, draws blood/breaks skin	⟩	
C1 = chase, ≤ 2 body lengths*	⟩	C = chase*
C2 = chase, >2 body lengths*	⟩	
D = displace*		
F1 = flee/move away, ≤ 2 body lengths	⟩	F = flee/move away
F2 = flee/move away, >2 body lengths	⟩	
J1 = joust ≤ 30 s*	⟩	J = joust/spar/fight*
J2 = joust >30 s*	⟩	
M1 = mount/attempted mount <30 s	⟩	M = mount/attempted
M2 = mount/attempted mount >30 s	⟩	
P = play*		

Appendix C.--Continued.

R = roll/present ventral

V = vocalize

Z = cruising (A/S 4 male only behavior, does not require a line number reference to another seal, but may have one)

b) spatial association

N = mother-pup pair (any distance)
L = association by location only (distance ≤ 10 m apart, for all except mother-pup pairs)

c) contests (optional) ---SEE CONTEST RULES---

L1 = pair assoc.* (A/S4 male paired with an adult female or immature of either sex)
Q = loser* \
W = winner* > codes used for A/S4 male-male contests only
Y = tie* /

* requires a corresponding code on the line of the associated seal

2) entangling object

L = association by location only (distance < 2 m)
E = subject is entangled

3) nothing nearby

O = no behavior or association

4) no data

X = no association data on census

CONTINUE--If the same animal is recorded on another line for any reason (e.g., additional tag or association, behavior at a later time, change of beach position), put the line number you are continuing *from* here. Lines may be continued only within the same page.

NOTES-- √ or 1 if you have handwritten notes on the observation. Put handwritten notes on the bottom of the census form, labeled by line number. The following note codes have specific meanings:

L = observation is purely incidental--i.e., not on census or patrol
R = seal is on rock offshore (combined with beach position 0)
D = seal is dead

Appendix C.--Continued.

Additional note codes (optional):

P = pregnant female
V = vestibule checked/status noted
W = initial wound sighting
E = seal is emaciated/very thin
F = seal is fat
G = seal is green with algae
T = tag condition noted
H = harassment/mobbing
S = snap shot/photo taken

Additional notes:

1. Weather information (except temperature) should be a summary of the entire day up until the end of the census, not merely an instantaneous observation.

2. A separate data sheet should be filled out for each date, observer, data type, and island within an atoll. If no seals are present, you should still fill out the information at the top of the census form and write "No seals" in the data area. If the island itself is not present, indicate this by using "99" for the sector code, leaving the rest of the (first) line blank.

3. All associations (except with entangling objects) should be in pairs, i.e., between animals on two different lines. If the behavior is active, you should fill in the line numbers, distances, and behavior codes for both animals involved in the association. If the behavior is N or L, however, you may record the association on only one of the lines, and the computer will fill in the other line.

4. An association should be *either* all blank *or* have the **O** or **X** behavior only, with no line number or distance, *or* have a line number, a distance, and some behavior code (other than **O** or **X**) all present.

5. On a census it is assumed that molt, disturbance, and behavioral data will be taken. Thus, on a census data sheet, no code in any of the A or B columns means that the seal was alone, whereas on a patrol data sheet, no code may simply mean that no data were taken. It is not necessary to put an **O** code for each unassociated animal on census. The computer will fill this in later. If you are unable to record association data on a census for any reason, indicate this information with an X for the behavior code.

6. Record all tag sightings explicitly (i.e., both left and right tag numbers) at least once during your stay. When a pup is tagged, record the first occurrence of that tag on a census data sheet for that date as well as on a tagging card. If a seal is identified via a tag, it is not necessary to determine and enter its ID number as well as tag number on the census form. The ID number will be added by computer later.

7. If two people conduct the census, they should have the same begin and end time (i.e., both begin at the same time and place, and proceed in opposite directions until they meet on the other side of the island or islet).

Appendix C.--Continued.

8. Only code the sex as known if the ventral is seen or if the seal is the mother in a mother/pup pair. A/S4 male only behavior codes can be used even if sex is unknown, and imply that the observer thinks that the seal is a male.

9. Be sure to code the *original* tag color, not the color that a tag has faded to.

Original tag color:	*Faded tag may appear:*
Temple Tags:	
Light Tan (A,T,K series @ Laysan)	Gray, Light Yellow, White
Dark Tan/Brown (later series @ Laysan)	--
Gray	Light Tan
Red	--
Yellow,	White, Light Yellow
Green (dark forest)	Dark Blue
Blue (light)	--
Riese Tags:	
White	Yellow
Red	--
Orange	--
Yellow	White
Green	Blue
Blue	Green

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